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Feuerman et al.

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(54) **CONTENT INTEGRITY AND INCREMENTAL SECURITY**

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H04L 29/06 (2006.01)

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(58) **Field of Classification Search**
CPC H04L 9/3247; H04L 63/00; H04L 2209/60
USPC 713/176
See application file for complete search history.

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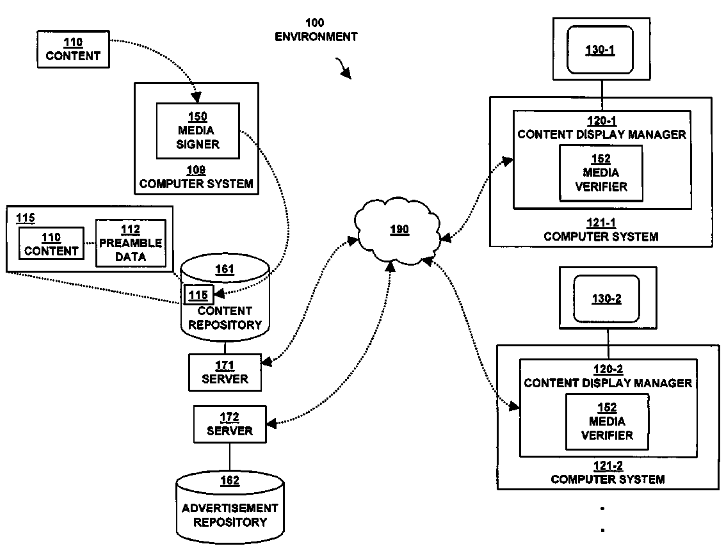
(74) *Attorney, Agent, or Firm* — Kilpatrick Townsend & Stockton LLP

(57) **ABSTRACT**

A media signer produces an array of hash values including a respective hash value for each of multiple different portions of content. The media signer applies a hash function and an encryption key to the array of hash values to create a digital signature associated with the content. Prior to playback of the content, a media verifier retrieves the array of hash values for the different portions of content. The media verifier produces a hash value result for the retrieved array. Based on the hash value result for the retrieved array and a hash value result of the array in the received digital signature, the media verifier verifies the integrity of the retrieved array. If the retrieved array of hash values is found to be trustworthy, the media verifier determines the integrity of a portion of the content by verifying the portion's corresponding hash value from the "trustworthy" array.

16 Claims, 14 Drawing Sheets



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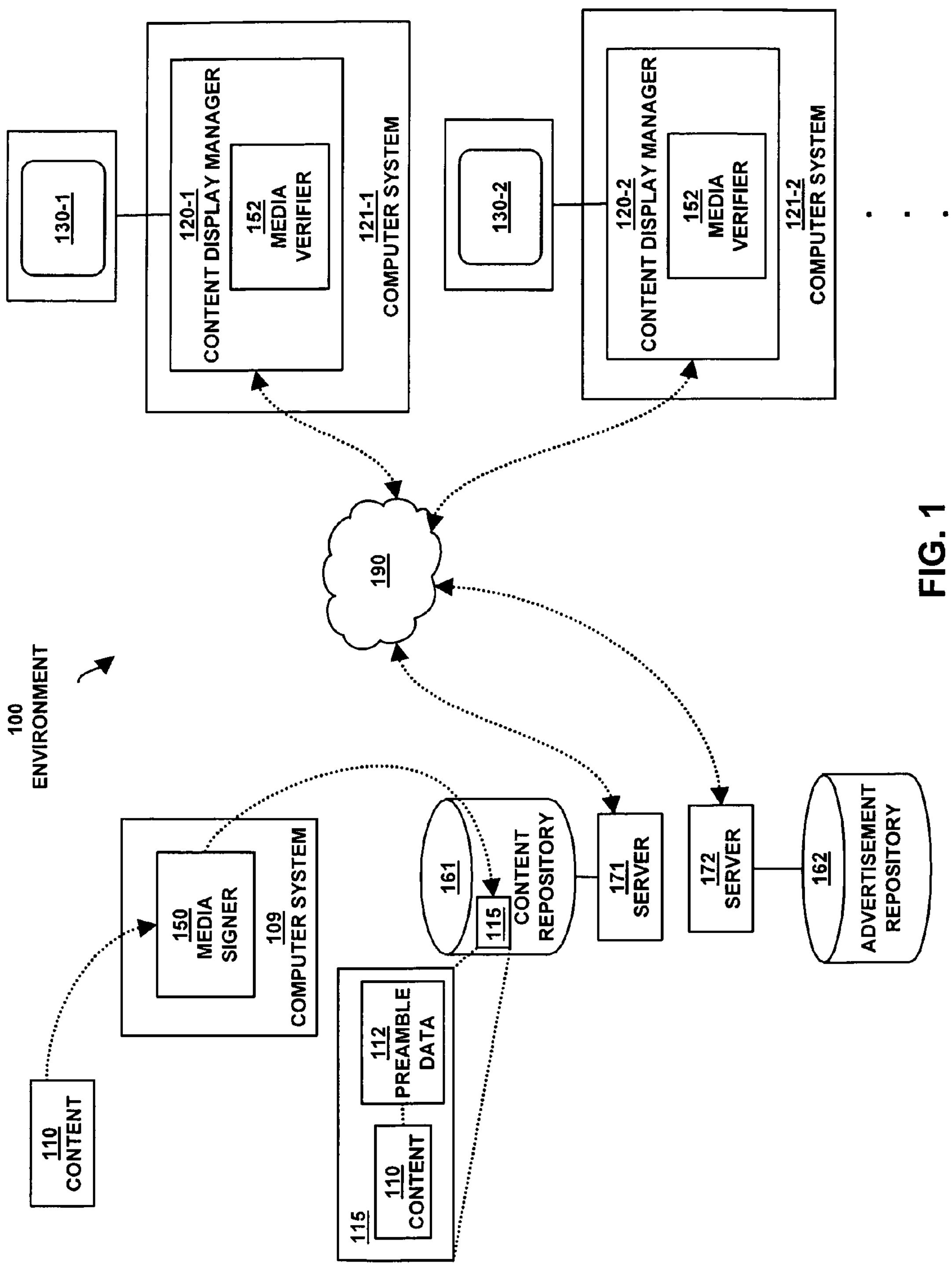

100
ENVIRONMENT
110
CONTENT
150
MEDIA
SIGNER
109
COMPUTER SYSTEM
115
110
CONTENT
112
PREAMBLE
DATA
161
115
CONTENT
REPOSITORY
171
SERVER
172
SERVER
162
ADVERTISEMENT
REPOSITORY
190
130-1
120-1
CONTENT DISPLAY MANAGER
152
MEDIA
VERIFIER
121-1
COMPUTER SYSTEM
130-2
120-2
CONTENT DISPLAY MANAGER
152
MEDIA
VERIFIER
121-2
COMPUTER SYSTEM

FIG. 1

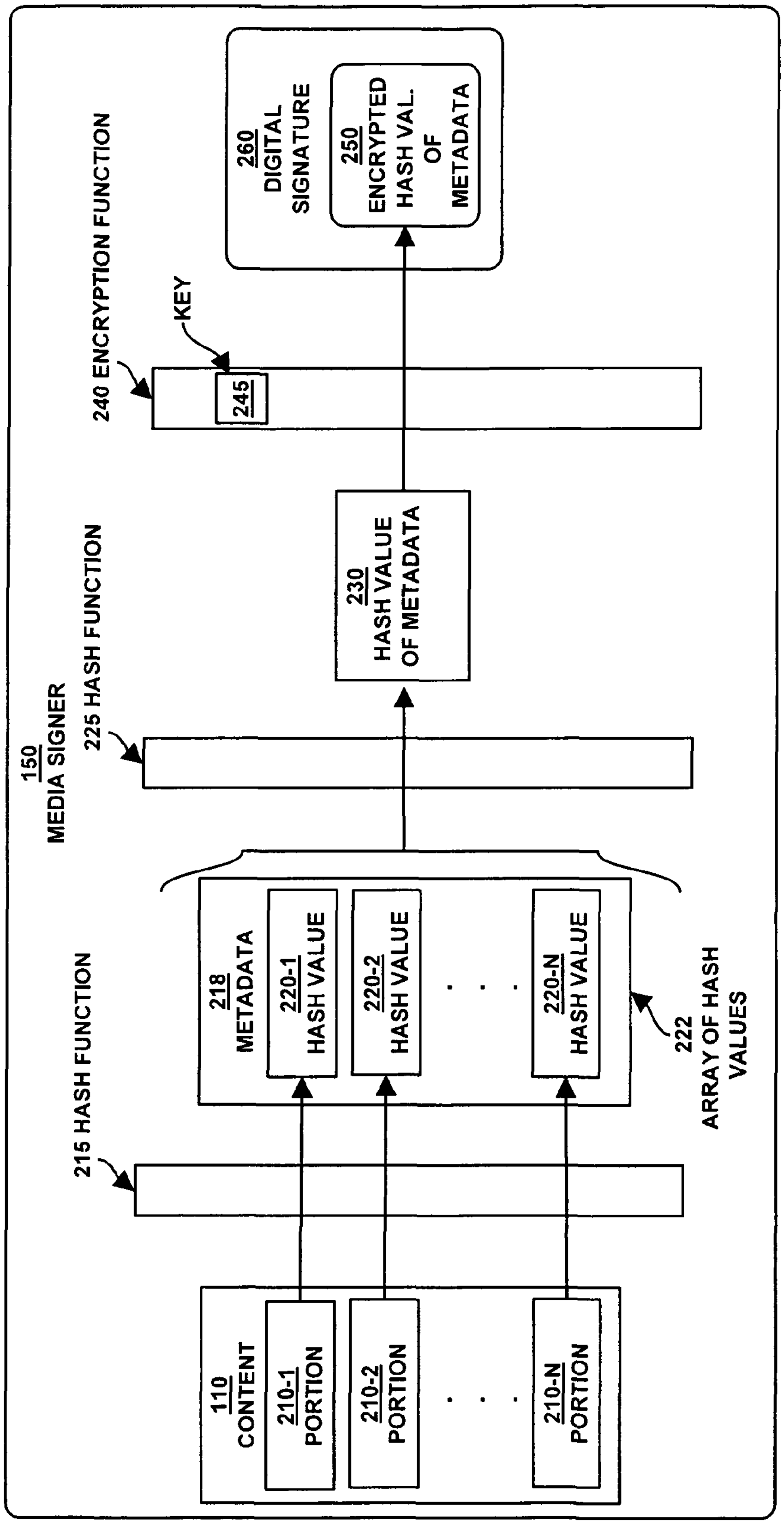
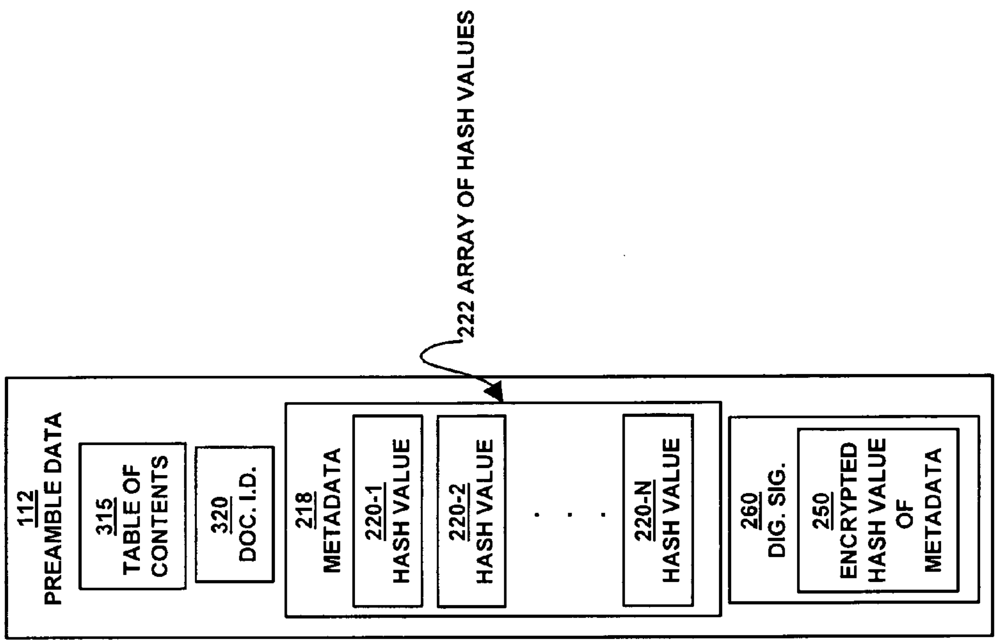

150
MEDIA SIGNER
110
CONTENT
210-1
PORTION
210-2
PORTION
210-N
PORTION
215 HASH FUNCTION
218
METADATA
220-1
HASH VALUE
220-2
HASH VALUE
220-N
HASH VALUE
222
ARRAY OF HASH VALUES
225 HASH FUNCTION
230
HASH VALUE OF METADATA
240 ENCRYPTION FUNCTION
KEY
245
260
DIGITAL SIGNATURE
250
ENCRYPTED HASH VAL. OF METADATA

FIG. 2



222 ARRAY OF HASH VALUES
112
PREAMBLE DATA
315
TABLE OF CONTENTS
320
DOC. I.D.
218
METADATA
220-1
HASH VALUE
220-2
HASH VALUE
. . .
220-N
HASH VALUE
260
DIG. SIG.
250
ENCRYPTED HASH VALUE OF METADATA

FIG. 3

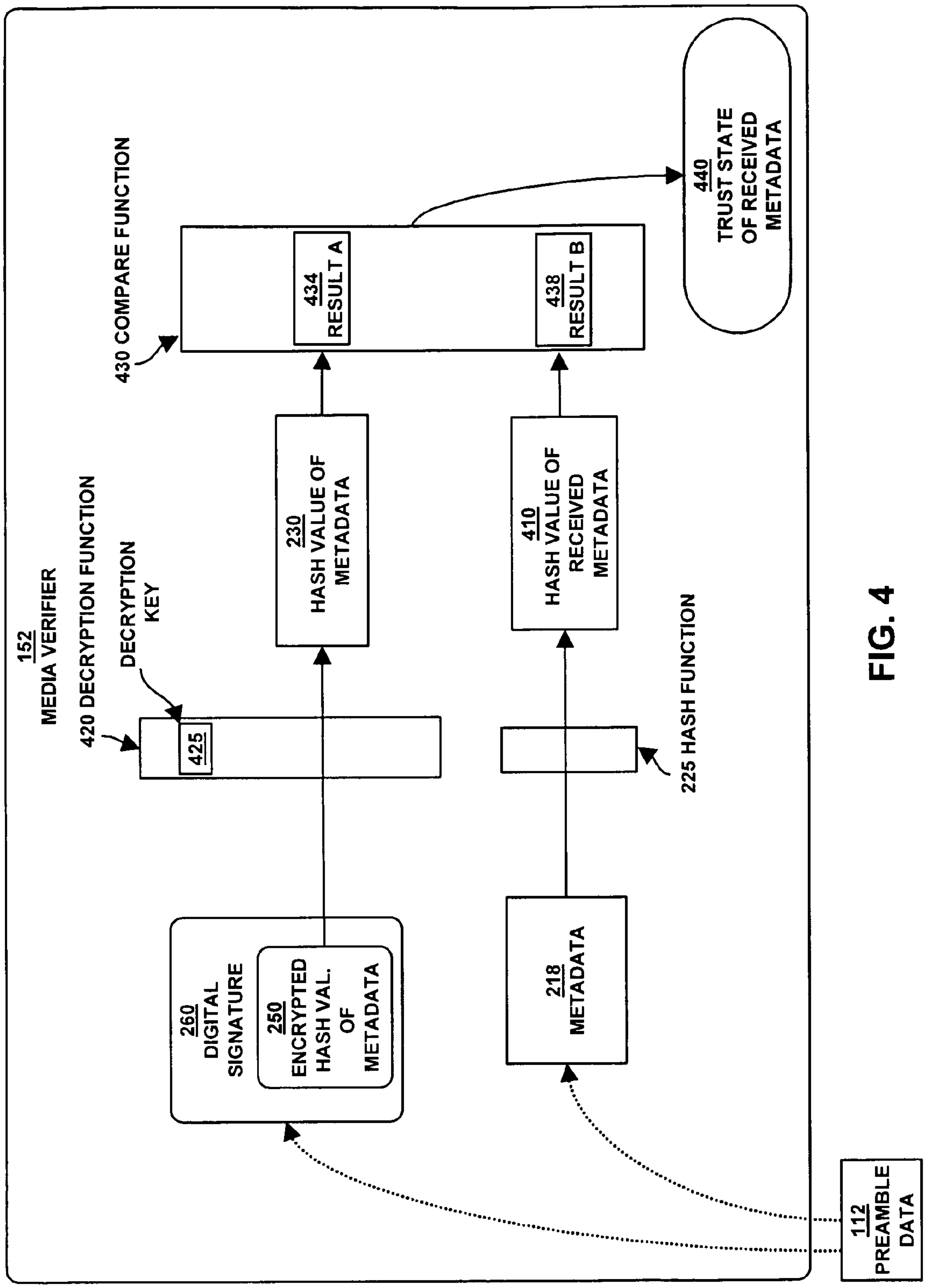

152
MEDIA VERIFIER
420 DECRYPTION FUNCTION
DECRYPTION KEY
425
260
DIGITAL SIGNATURE
250
ENCRYPTED HASH VAL. OF METADATA
230
HASH VALUE OF METADATA
218
METADATA
225 HASH FUNCTION
410
HASH VALUE OF RECEIVED METADATA
430 COMPARE FUNCTION
434
RESULT A
438
RESULT B
440
TRUST STATE OF RECEIVED METADATA
112
PREAMBLE DATA

FIG. 4

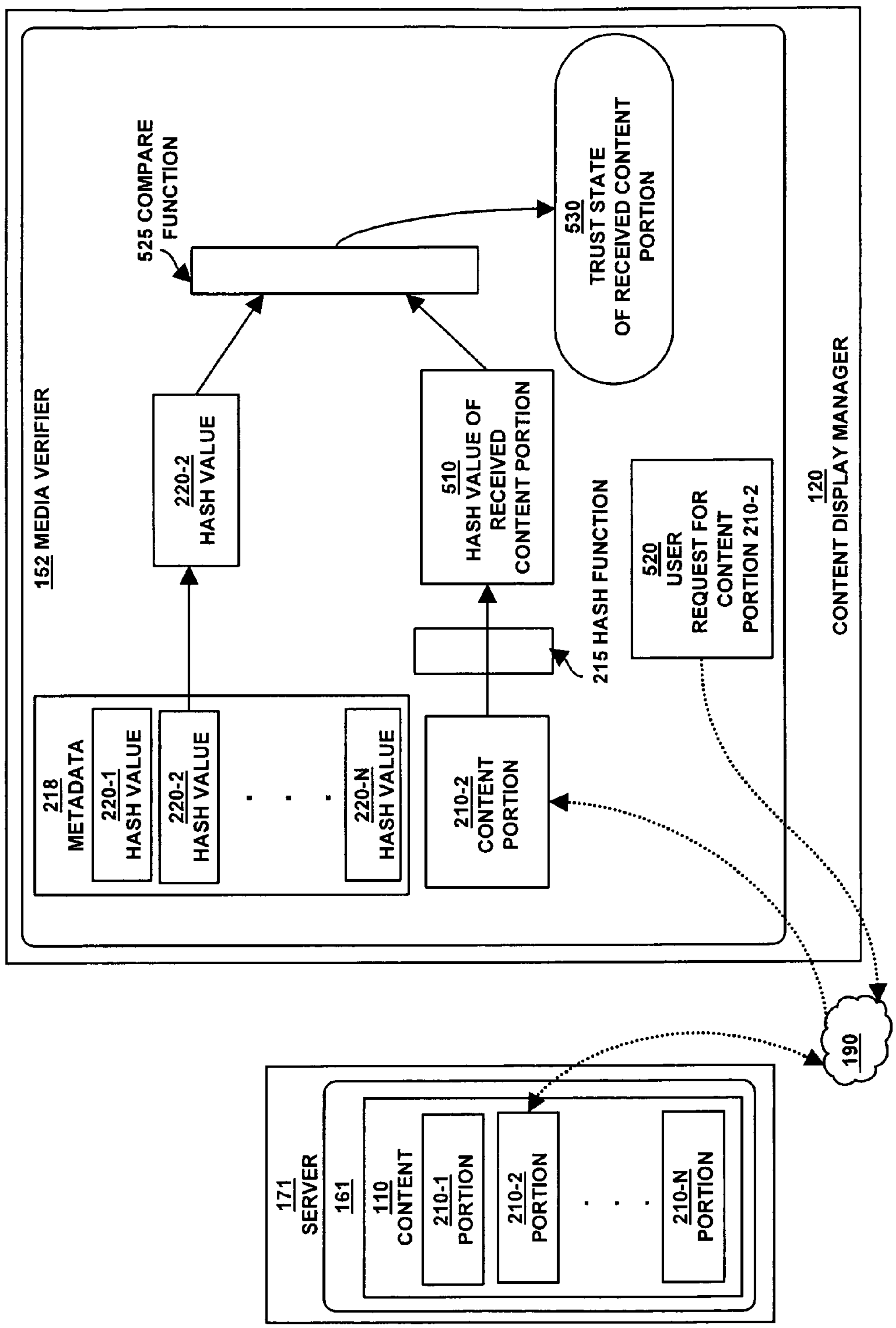

152 MEDIA VERIFIER
525 COMPARE FUNCTION
530 TRUST STATE OF RECEIVED CONTENT PORTION
220-2 HASH VALUE
510 HASH VALUE OF RECEIVED CONTENT PORTION
215 HASH FUNCTION
218 METADATA
220-1 HASH VALUE
220-2 HASH VALUE
220-N HASH VALUE
210-2 CONTENT PORTION
520 USER REQUEST FOR CONTENT PORTION 210-2
120 CONTENT DISPLAY MANAGER
190
171 SERVER
161
110 CONTENT
210-1 PORTION
210-2 PORTION
210-N PORTION

FIG. 5

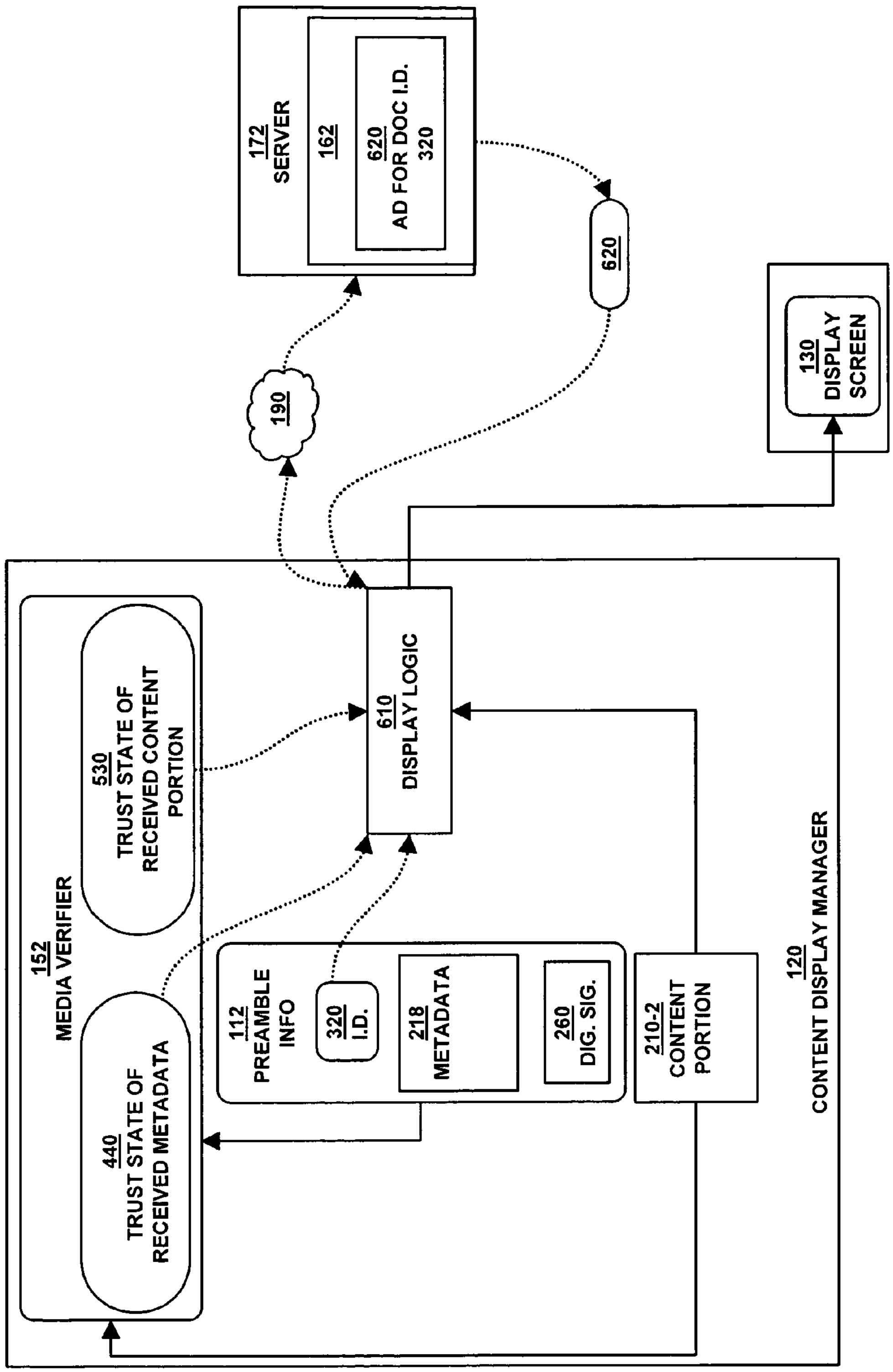

172
SERVER
162
620
AD FOR DOC I.D.
320
620
190
130
DISPLAY
SCREEN
152
MEDIA VERIFIER
530
TRUST STATE OF
RECEIVED CONTENT
PORTION
440
TRUST STATE OF
RECEIVED METADATA
610
DISPLAY LOGIC
112
PREAMBLE
INFO
320
I.D.
218
METADATA
260
DIG. SIG.
210-2
CONTENT
PORTION
120
CONTENT DISPLAY MANAGER

FIG. 6

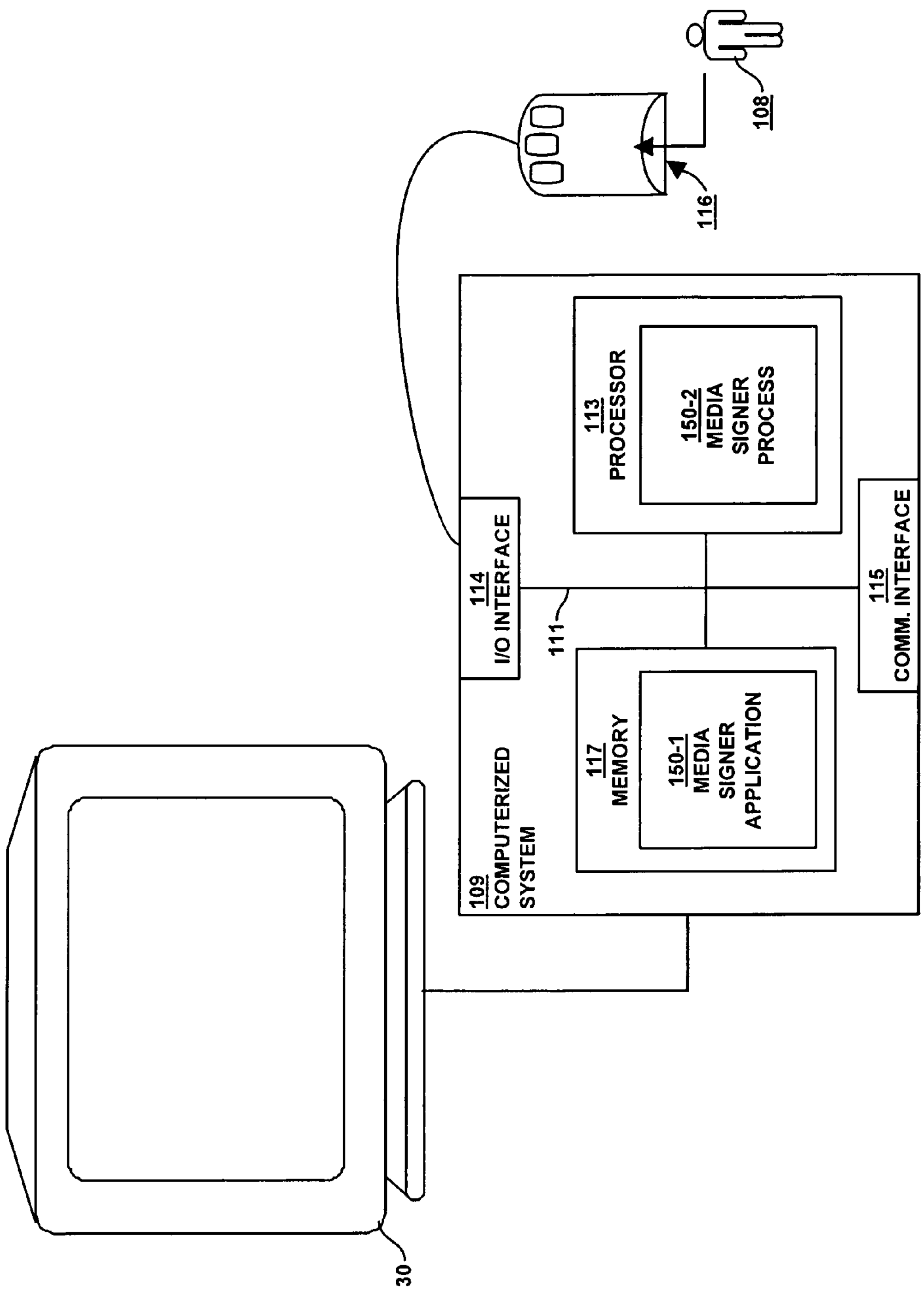

108
116
113
PROCESSOR
150-2
MEDIA
SIGNER
PROCESS
114
I/O INTERFACE
111
115
COMM. INTERFACE
117
MEMORY
150-1
MEDIA
SIGNER
APPLICATION
109
COMPUTERIZED
SYSTEM
130

FIG. 7

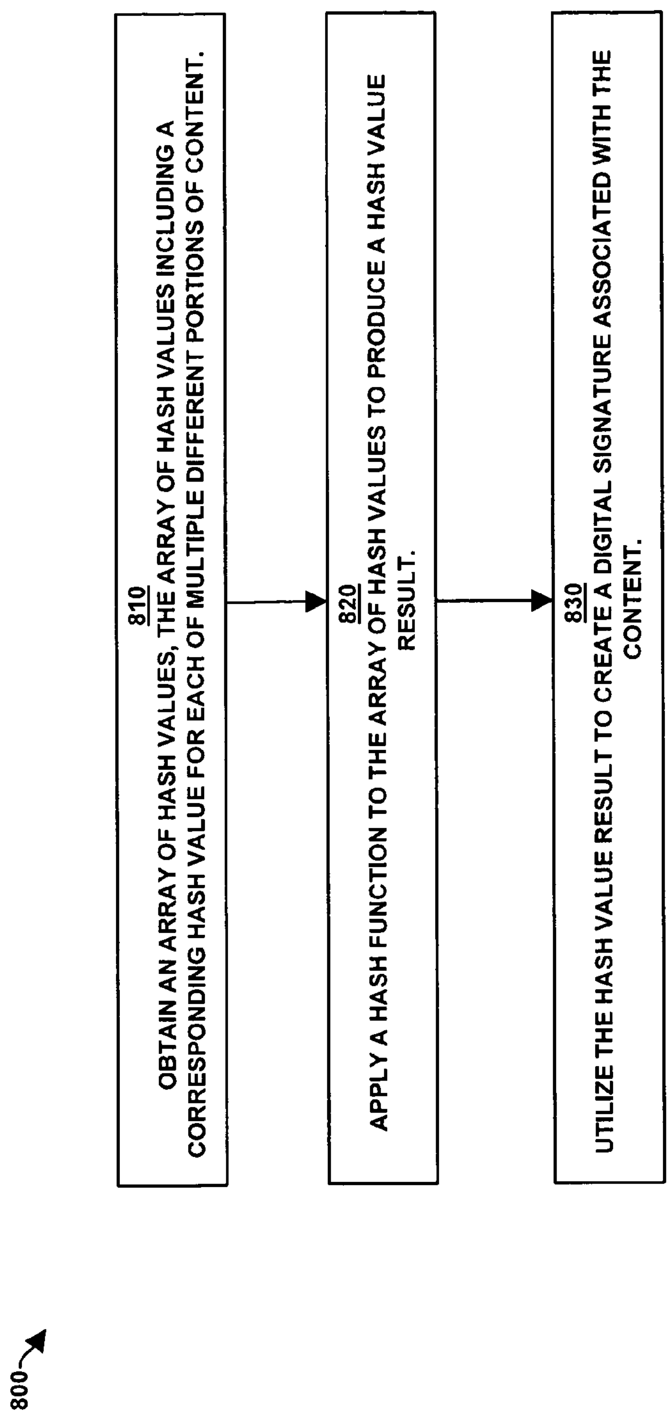

800
810
OBTAIN AN ARRAY OF HASH VALUES, THE ARRAY OF HASH VALUES INCLUDING A CORRESPONDING HASH VALUE FOR EACH OF MULTIPLE DIFFERENT PORTIONS OF CONTENT.
820
APPLY A HASH FUNCTION TO THE ARRAY OF HASH VALUES TO PRODUCE A HASH VALUE RESULT.
830
UTILIZE THE HASH VALUE RESULT TO CREATE A DIGITAL SIGNATURE ASSOCIATED WITH THE CONTENT.

FIG. 8

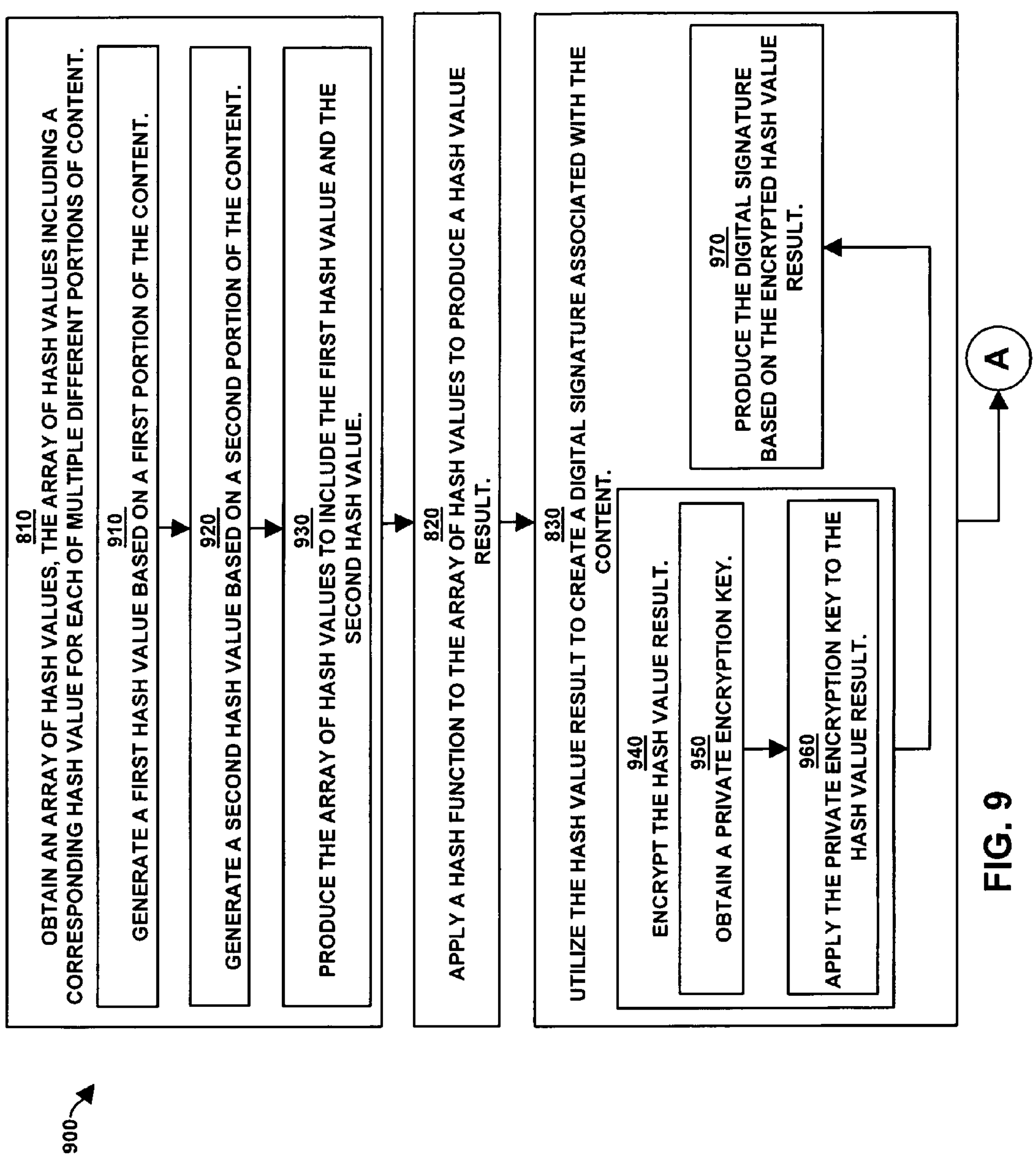

900
810
OBTAIN AN ARRAY OF HASH VALUES, THE ARRAY OF HASH VALUES INCLUDING A CORRESPONDING HASH VALUE FOR EACH OF MULTIPLE DIFFERENT PORTIONS OF CONTENT.
910
GENERATE A FIRST HASH VALUE BASED ON A FIRST PORTION OF THE CONTENT.
920
GENERATE A SECOND HASH VALUE BASED ON A SECOND PORTION OF THE CONTENT.
930
PRODUCE THE ARRAY OF HASH VALUES TO INCLUDE THE FIRST HASH VALUE AND THE SECOND HASH VALUE.
820
APPLY A HASH FUNCTION TO THE ARRAY OF HASH VALUES TO PRODUCE A HASH VALUE RESULT.
830
UTILIZE THE HASH VALUE RESULT TO CREATE A DIGITAL SIGNATURE ASSOCIATED WITH THE CONTENT.
940
ENCRYPT THE HASH VALUE RESULT.
950
OBTAIN A PRIVATE ENCRYPTION KEY.
960
APPLY THE PRIVATE ENCRYPTION KEY TO THE HASH VALUE RESULT.
970
PRODUCE THE DIGITAL SIGNATURE BASED ON THE ENCRYPTED HASH VALUE RESULT.
A

FIG. 9

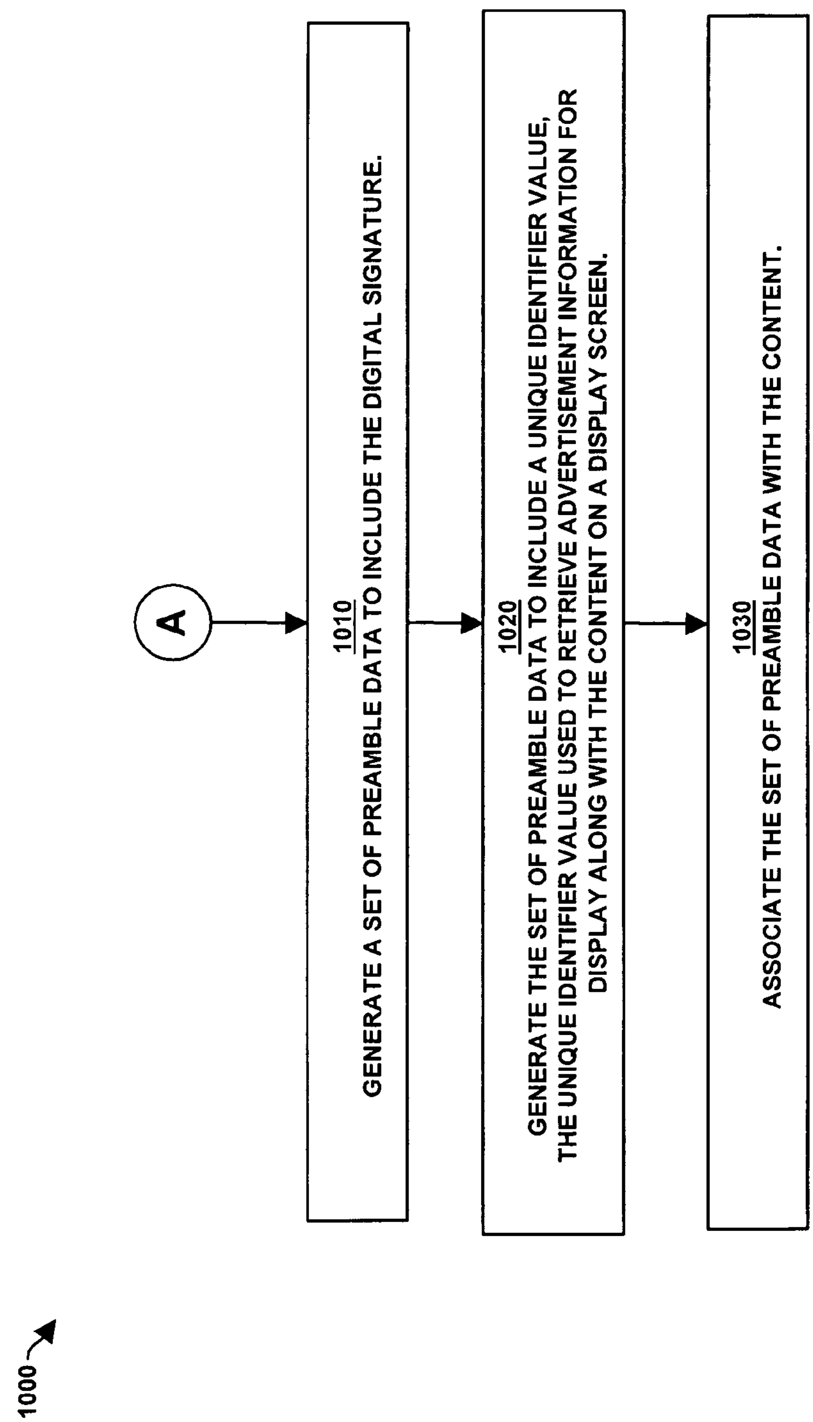

1000
A
1010
GENERATE A SET OF PREAMBLE DATA TO INCLUDE THE DIGITAL SIGNATURE.
1020
GENERATE THE SET OF PREAMBLE DATA TO INCLUDE A UNIQUE IDENTIFIER VALUE, THE UNIQUE IDENTIFIER VALUE USED TO RETRIEVE ADVERTISEMENT INFORMATION FOR DISPLAY ALONG WITH THE CONTENT ON A DISPLAY SCREEN.
1030
ASSOCIATE THE SET OF PREAMBLE DATA WITH THE CONTENT.

FIG. 10

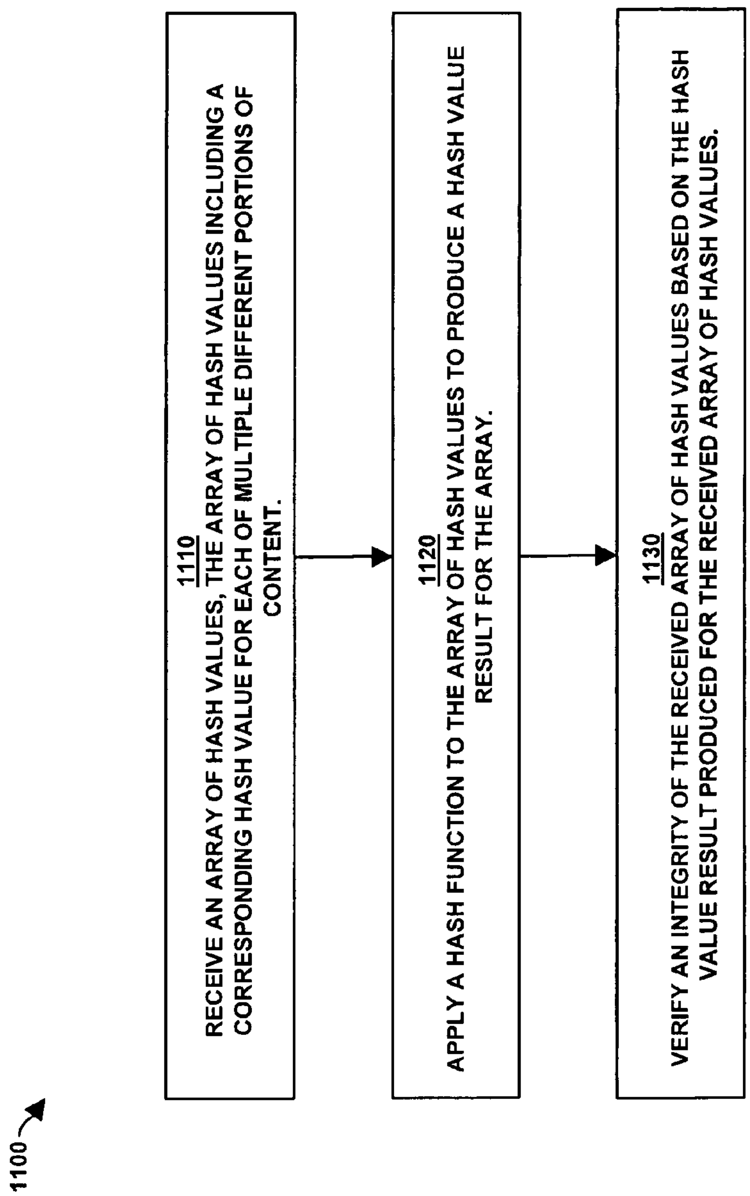

1100
1110
RECEIVE AN ARRAY OF HASH VALUES, THE ARRAY OF HASH VALUES INCLUDING A CORRESPONDING HASH VALUE FOR EACH OF MULTIPLE DIFFERENT PORTIONS OF CONTENT.
1120
APPLY A HASH FUNCTION TO THE ARRAY OF HASH VALUES TO PRODUCE A HASH VALUE RESULT FOR THE ARRAY.
1130
VERIFY AN INTEGRITY OF THE RECEIVED ARRAY OF HASH VALUES BASED ON THE HASH VALUE RESULT PRODUCED FOR THE RECEIVED ARRAY OF HASH VALUES.

FIG. 11

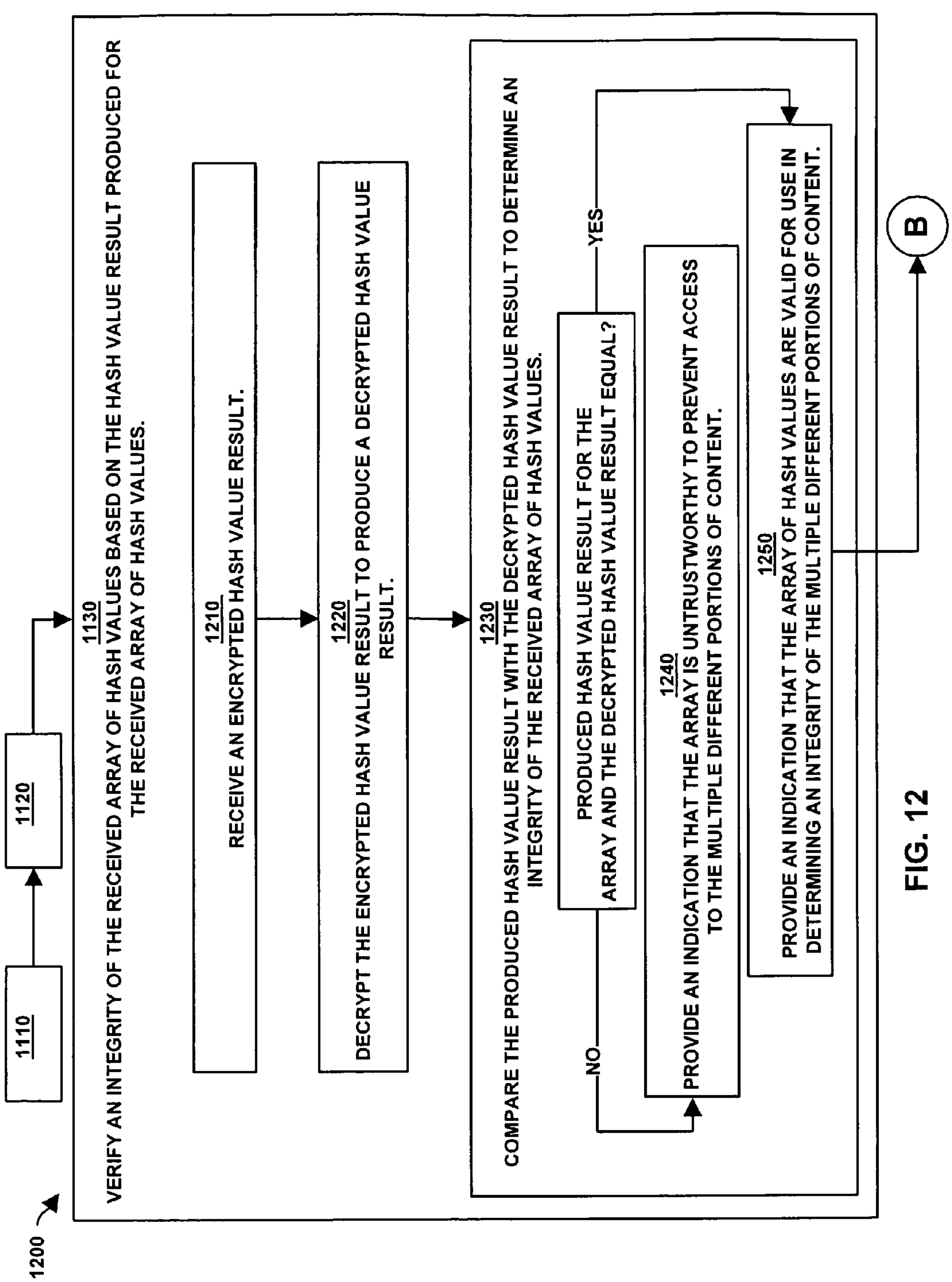

1200
1110
1120
1130
VERIFY AN INTEGRITY OF THE RECEIVED ARRAY OF HASH VALUES BASED ON THE HASH VALUE RESULT PRODUCED FOR THE RECEIVED ARRAY OF HASH VALUES.
1210
RECEIVE AN ENCRYPTED HASH VALUE RESULT.
1220
DECRYPT THE ENCRYPTED HASH VALUE RESULT TO PRODUCE A DECRYPTED HASH VALUE RESULT.
1230
COMPARE THE PRODUCED HASH VALUE RESULT WITH THE DECRYPTED HASH VALUE RESULT TO DETERMINE AN INTEGRITY OF THE RECEIVED ARRAY OF HASH VALUES.
PRODUCED HASH VALUE RESULT FOR THE ARRAY AND THE DECRYPTED HASH VALUE RESULT EQUAL?
YES
NO
1240
PROVIDE AN INDICATION THAT THE ARRAY IS UNTRUSTWORTHY TO PREVENT ACCESS TO THE MULTIPLE DIFFERENT PORTIONS OF CONTENT.
1250
PROVIDE AN INDICATION THAT THE ARRAY OF HASH VALUES ARE VALID FOR USE IN DETERMINING AN INTEGRITY OF THE MULTIPLE DIFFERENT PORTIONS OF CONTENT.
B

FIG. 12

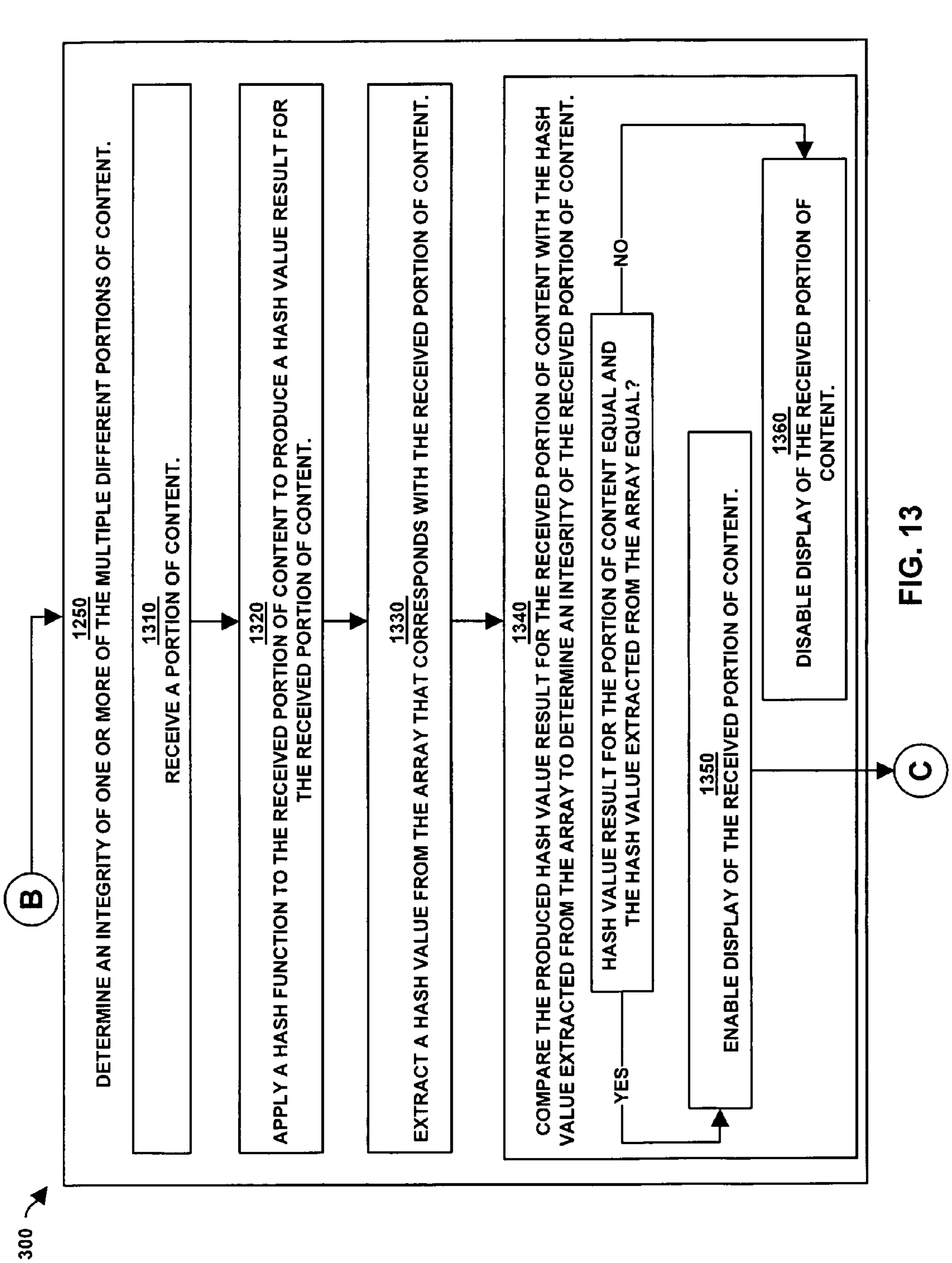

B
1300
1250
DETERMINE AN INTEGRITY OF ONE OR MORE OF THE MULTIPLE DIFFERENT PORTIONS OF CONTENT.
1310
RECEIVE A PORTION OF CONTENT.
1320
APPLY A HASH FUNCTION TO THE RECEIVED PORTION OF CONTENT TO PRODUCE A HASH VALUE RESULT FOR THE RECEIVED PORTION OF CONTENT.
1330
EXTRACT A HASH VALUE FROM THE ARRAY THAT CORRESPONDS WITH THE RECEIVED PORTION OF CONTENT.
1340
COMPARE THE PRODUCED HASH VALUE RESULT FOR THE RECEIVED PORTION OF CONTENT WITH THE HASH VALUE EXTRACTED FROM THE ARRAY TO DETERMINE AN INTEGRITY OF THE RECEIVED PORTION OF CONTENT.
HASH VALUE RESULT FOR THE PORTION OF CONTENT EQUAL AND THE HASH VALUE EXTRACTED FROM THE ARRAY EQUAL?
YES
NO
1350
ENABLE DISPLAY OF THE RECEIVED PORTION OF CONTENT.
1360
DISABLE DISPLAY OF THE RECEIVED PORTION OF CONTENT.
C

FIG. 13

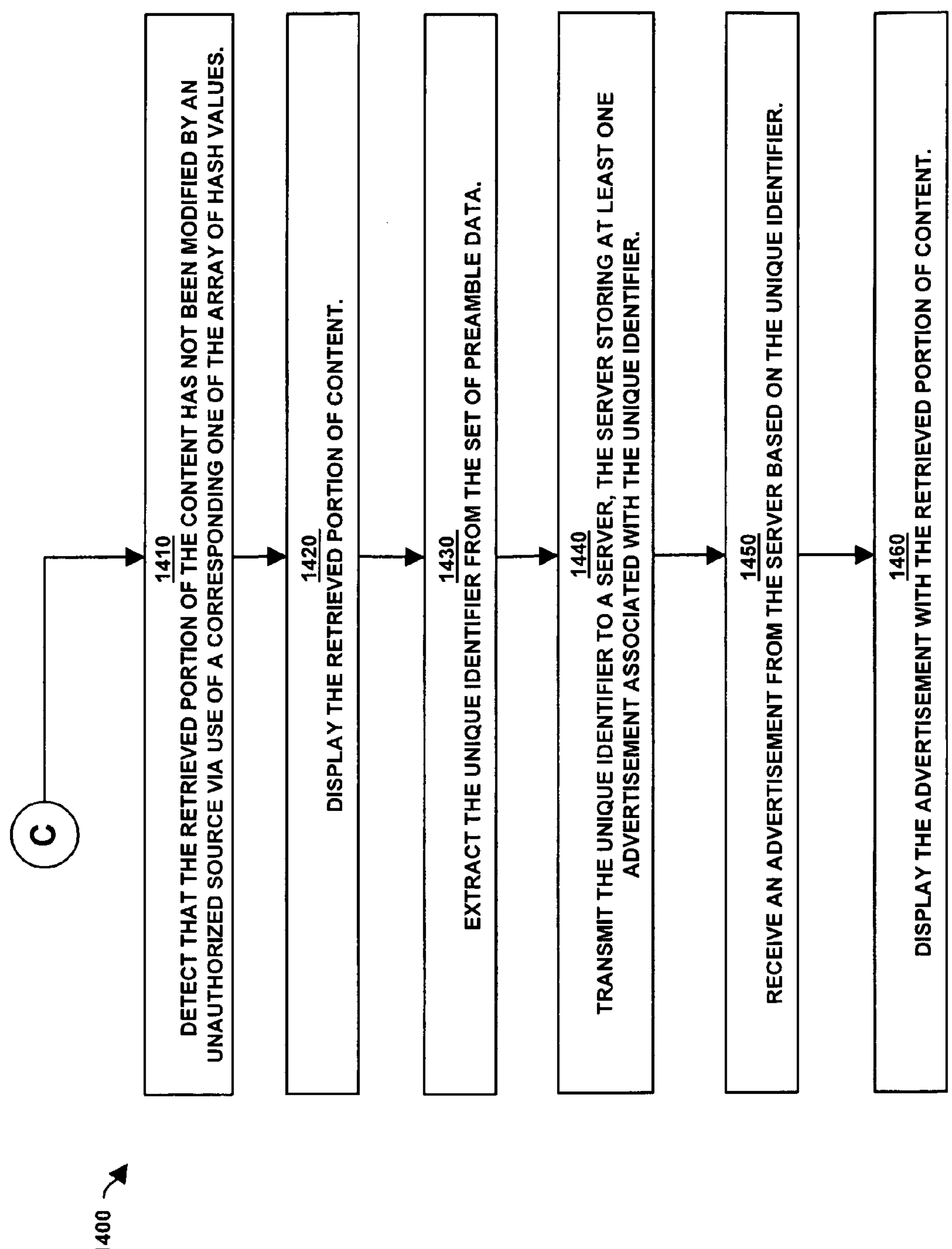

C
1400
1410
DETECT THAT THE RETRIEVED PORTION OF THE CONTENT HAS NOT BEEN MODIFIED BY AN UNAUTHORIZED SOURCE VIA USE OF A CORRESPONDING ONE OF THE ARRAY OF HASH VALUES.
1420
DISPLAY THE RETRIEVED PORTION OF CONTENT.
1430
EXTRACT THE UNIQUE IDENTIFIER FROM THE SET OF PREAMBLE DATA.
1440
TRANSMIT THE UNIQUE IDENTIFIER TO A SERVER, THE SERVER STORING AT LEAST ONE ADVERTISEMENT ASSOCIATED WITH THE UNIQUE IDENTIFIER.
1450
RECEIVE AN ADVERTISEMENT FROM THE SERVER BASED ON THE UNIQUE IDENTIFIER.
1460
DISPLAY THE ADVERTISEMENT WITH THE RETRIEVED PORTION OF CONTENT.

FIG. 14

CONTENT INTEGRITY AND INCREMENTAL SECURITY

BACKGROUND

Conventional computer systems allow for the production and distribution of content such as video data, audio data, image data, text-based data, etc. Such distribution and production is increasing at a phenomenal rate due to the growing popularity of the Internet and the growing affordability of personal computers capable of efficiently processing and displaying content to users.

People now access and use content in numerous ways. One way that people access content is over a network. For example, persons using web browsers on personal computers can access content by surfing the World Wide Web via the Internet. Countless numbers of content providers link content to web pages accessed by persons using web browsers. Accordingly, persons using web browsers can access a web page from a web server operated by a content provider to view documents, video clips, listen to audio clips, or view images made available by the content provider.

In a typical application, when a client requests a piece of media content from a server, the client provides a global address associated with the content in the form of a Uniform Resource Locator (URL). Based on receiving a request at a location as specified by the global address, a server then accesses the content and sends or "streams" it to the client in accordance with an appropriate communication protocol.

There are various file formats for streaming media content and composite media streams. Regardless of the streaming file format used, an individual data stream may contain a sequence of digital data sets or units. The units can represent an image, sound, or some other stimuli "played back" to a viewer via a client.

The integrity of distributed media content can be enhanced using conventional security measures. For example, content can be digitally signed using conventional hashing and encryption techniques prior to being distributed for "playback" by one or more different users. A processing device receiving content can be configured to use the conventional digital signature to verify a trustworthiness of received content prior to play back of the digitally signed content. Conventional security techniques require verification of an entire grouping of media content before the user is afforded access to any segment of the media content.

SUMMARY

Conventional computer systems suffer from a number of deficiencies. For example, as discussed above, conventional systems can be configured to protect content integrity by producing a digital signature for a grouping of content as a whole. In order to verify the content using the conventional digital signature, a user must retrieve the content in its entirety and thereafter apply a conventional verifier function to the content as whole to determine whether the content has been tampered with or corrupted.

This conventional technique of verifying content can be an impediment to quickly displaying requested content. For example, a user may request to download a single page of a large multi-page document for viewing. Assume that the multi-page document happens to be digitally signed according to conventional techniques. Prior to displaying a page within the document and based on use of the conventional digital signature, the user must download the whole document and apply a conventional verifier function to the document as a whole to determine the integrity of the document. The download may take a substantial amount of time due to a length of the document. This affects how quickly a requested page of the document can be displayed. To view a single requested page of the multi-page document, the user may have to wait to download and verify all portions of the document, even those that will not be viewed by the user.

Certain example embodiments as discussed herein significantly overcome the deficiencies of conventional applications such as those discussed above. For example, certain specific embodiments herein are directed to a computer environment for providing improved content integrity over conventional methods.

More specifically, according to one embodiment, a media signer parses content (e.g., a multi-page .pdf document, a movie, a music album, a slide presentation) into portions (e.g., single pages, video chapters, songs, single images, etc.). The media signer produces a hash value for each portion of multiple portions of the content to produce an array of hash values. Additionally, the media signer applies a hash function to the array of hash values to produce a hash value result. In an example embodiment, the media signer then utilizes the hash value result to create a digital signature for the content by applying an encryption key (e.g., a private key) to the hash value result.

After creating the digital signature, the media signer associates the digital signature with the content for distribution of the content to one or more remote devices that perform operations such as play back of the content. The array of hash values associated with the content can also be made available for distribution to the one or more remote devices receiving the content for verification purposes. As an example, prior to play back of the content on a remote device such as a media player, a media verifier configured according to embodiments herein utilizes the digital signature to first verify an integrity of a retrieved array of hash values associated with the content.

More specifically, a media verifier retrieves the array of hash values associated with the content. Note that the array of hash values can be retrieved by the media verifier along with one or more requested portions of content. However, the content in its entirety (i.e. all portions of content) need not be retrieved to determine the integrity of a particular requested portion of content.

Initially, it is unknown whether the retrieved array of hash values is "trustworthy." To verify an integrity of the retrieved array of hash values, the media verifier applies a hash function to the retrieved array of hash values and decrypts the digital signature using an appropriate decryption key. To complete a verification of the retrieved array of hash values, the media verifier compares the decrypted digital signature with the hashed retrieved array of hash values. If they are equivalent, then the retrieved array passes the verification test. If not, the retrieved array does not pass the verification test.

When the media verifier detects that the retrieved array is "untrustworthy" (e.g., because it was been modified by an unauthorized source, because there was a communication error during transmission of the array, etc.), the media verifier reports such detection to the media player, which determines the appropriate use of the content represented by the "untrustworthy" array. For example, in one embodiment, in response to determining that an array is untrustworthy (e.g., fails a security check), the media player can merely provide an indication of a tampered status of the media. According to another embodiment, the media player can refuse or prevent play back of content in response to detecting that the array is untrustworthy.

However, when the media verifier detects that the array of hash values is "trustworthy" based on the above verification test, the media verifier enables use of the retrieved array for use in determining the integrity of any of the multiple different portions of content. For example, a user of a media player may request to view a particular portion of the content. In order to determine the integrity of the particular portion of content, the media verifier first receives the particular portion of content. Thereafter, the media verifier applies a hash function to the particular portion of content to produce a hash value result for the retrieved particular portion of content. The media verifier then retrieves a hash value from the retrieved array of hash values (e.g., which was found to be "trustworthy") that corresponds with the particular portion of content. The media verifier then compares the hash value result produced for the particular portion of content with the hash value extracted from the retrieved array of hash values to determine an integrity of the received particular portion of content.

If the received portion of content's integrity is "trustworthy" based on the comparison (e.g., because there is a match), the media verifier can enable use (e.g., display) of the particular portion of content. If the media verifier determines that the particular portion of content is "untrustworthy" based on the comparison, the media verifier can prevent use (e.g., display) of the particular portion of content.

Example embodiments as described herein are advantageous over conventional techniques. For example, conventional techniques such as those discussed above in the background do not allow for determining which pages of a document are corrupted and which are still valid because the conventional verification test is based on an entirety of content rather than portions of content. Failure of the conventional verification test results in the inability to view any portions of the content. The user in such circumstances, therefore, may be prevented from viewing a desired page even though it may be that another page in a retrieved document that happens to be corrupted. In contradistinction and according to embodiments herein, if a retrieved array of hash values passes the verification test, then the array of hash values can be used to verify each requested portion of the content on a case-by-case basis. Those portions of content that pass the verification test can be displayed to a user.

Thus, example embodiments as discussed herein contrast with conventional systems because they can be used to detect whether a portion of content has been altered by an unauthorized source without requiring access and application of a verifier function to the content in its entirety. Further, example embodiments herein enable a user to access and view non-corrupted portions of a document even though other portions of the same document may be corrupted and, therefore, not usable.

Note that in addition to the media signer and media verifier, other embodiments disclosed herein include any type of computerized device, workstation, handheld or laptop computer, or the like configured with software and/or circuitry (e.g., a processor) to process any or all of the method operations disclosed herein. In other words, a computerized device such as a computer or a data communications device or any type of processor that is programmed or configured to operate as explained herein is considered an embodiment disclosed herein.

Other embodiments disclosed herein include software programs to perform the steps and operations summarized above and disclosed in detail below. One such embodiment comprises a computer program product that has a computer-readable medium (e.g., tangible computer-readable medium) including computer program logic encoded thereon that, when performed in a computerized device having a coupling of a memory and a processor, programs the processor to perform the operations disclosed herein. Such arrangements are typically provided as software, code and/or other data (e.g., data structures) arranged or encoded on a computer readable medium such as an optical medium (e.g., CD-ROM), floppy or hard disk or other a medium such as firmware or microcode in one or more ROM or RAM or PROM chips or as an Application Specific Integrated Circuit (ASIC). The software or firmware or other such configurations can be installed onto a computerized device to cause the computerized device to perform the techniques explained as embodiments disclosed herein.

It is to be understood that the system disclosed herein may be embodied strictly as a software program, as software and hardware, or as hardware alone. The embodiments disclosed herein, may be employed in software and hardware such as those manufactured by Adobe Systems Incorporated of San Jose, Calif., U.S.A., herein after referred to as "Adobe" and "Adobe Systems."

As discussed above, techniques herein are well suited for use in computer applications such as those used to digitally sign and verify content. However, it should be noted that embodiments herein are not limited to use in such applications and that the techniques discussed herein are well suited for other applications as well.

Additionally, although each of the different features, techniques, configurations, etc. herein may be discussed in different places of this disclosure, it is intended that each of the concepts can be executed independently of each other or in combination with each other. Accordingly, at least some example configurations as described herein can be embodied and viewed in many different ways.

Note also that this summary section herein does not specify every embodiment and/or incrementally novel aspect of the present disclosure or claimed invention. Instead, this summary only provides a preliminary discussion of different embodiments and corresponding points of novelty over conventional techniques. For additional details and/or possible perspectives (permutations) of the invention and example embodiments, the reader is directed to the Detailed Description section and corresponding figures of the present disclosure as further discussed below.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing and other objects, features and advantages of the invention will be apparent from the following more particular description of embodiments of an environment with a media signer and a media verifier, as illustrated in the accompanying drawings and figures in which like reference characters refer to the same parts throughout the different views. The drawings are not necessarily to scale, with emphasis instead being placed upon illustrating the embodiments, principles and concepts of the methods and apparatus in accordance with the invention.

FIG. **1** is a block diagram of an example of an environment including a media signer and a media verifier for securing data according to embodiments herein.

FIG. **2** is a block diagram of an example of a media signer according to embodiments herein.

FIG. **3** is a block diagram of an example of preamble data according to embodiments herein.

FIG. **4** is a block diagram of an example of a media verifier configured to verify the integrity of received metadata according to embodiments herein.

FIG. **5** is a block diagram of an example of a media verifier configured to verify the integrity of a received portion of content according to embodiments herein.

FIG. **6** is a block diagram of an example of a content display manager including a media verifier configured to enable display of verified portions of content and with related advertisement information according to embodiments herein.

FIG. **7** is an example block diagram illustrating an architecture of a computer system that can be configured to execute a media signer application and/or a media verifier application according to embodiments herein.

FIG. **8** is a flowchart of an example of processing steps performed by a media signer configured to create a digital signature according to embodiments herein.

FIGS. **9** and **10** combine to form a flowchart of an example of processing steps performed by a media signer or related functions to produce a digital signature according to embodiments herein.

FIG. **11** is a flowchart of an example of processing steps performed by a media verifier configured to verify the integrity of a received array of hash values according to embodiments herein.

FIGS. **12-14** combine to form an example flowchart illustrating verification of an array of hash values and different portions of content according to embodiments herein.

DETAILED DESCRIPTION

According to embodiments herein, a media signer produces an array of hash values including a respective hash value for each of multiple different portions of content. The media signer applies a hash function and an encryption key to the array of hash values to create a digital signature associated with the content.

Prior to playback of the content, a media verifier retrieves the array of hash values for the different portions of content. The media verifier produces a hash value result for the retrieved array. Based on the hash value result (as derived by the media verifier) for the retrieved array and a corresponding hash value result for the array in the received digital signature, the media verifier verifies the integrity of the retrieved array. In other words, according to one embodiment, the media verifier checks a trustworthiness of the retrieved array of hash values by verifying that the hash value produced for the retrieved array is equivalent to the hash value in the digital signature. If the retrieved array of hash values is found to be "trustworthy" (e.g., that the array has not been modified by an unauthorized source), the media verifier determines the integrity of content portions by processing the hash values in the "trustworthy" retrieved array as discussed in more detail below.

Turning now to FIG. **1**, FIG. **1** is a block diagram of an example of an environment **100** that includes a media signer **150** and a media verifier **152** according to embodiments herein. In general, as shown in FIG. **1**, a media signer **150** produces security information for associating with content **110** and portions thereof. The media signer **150** stores the security information in preamble data **112**. Repository **161** stores the preamble data **112** (including security information) as well as content **112** for distribution to remote computers. Computer systems **121** retrieve the content for playback on corresponding display screens **130**. Prior to playback, however, content display manager executing on the remote computer systems **121** utilize corresponding media verifiers **152** to detect (e.g., via processing of security information in the preamble data **112** and processing of the content **110**) whether content **110** (or portions thereof) can be played back for viewing.

More specifically, as illustrated in FIG. **1**, media signer **150** runs on a computer system **109** and generates preamble data **112** based on content **110** processed by the media signer **150**. As mentioned above, the preamble data **112** can include security data such as an array of hash values used for verifying content **110** as further discussed below in the following figures.

After generating the preamble data **112**, the media signer **150** associates the preamble data **112** with the content **110** and stores the preamble data **112** and content **110** at a location **115** in a content repository **161**.

Data stored in the content repository **161** is accessible over a network **190** via a server **171**.

Computer systems **121** (e.g., computer system **121-1**, computer system **121-2**, . . .) communicate over network **190** to retrieve content **110** (or portions thereof) from repository **161** for playback of the content **110** (or portions thereof on respective display screens **130** (e.g., display screen **130-1**, display screen **130-2**, . . .). As an example, a content display manager **120-1**, which runs on a computer system **121-1**, can send a request over network **190** to server **171** for retrieval and viewing of one or more portions of the content **110**.

In response to the request for the portion(s) of content **110**, the server **171** sends the preamble data **112** as well as the portion(s) of content **110** to the content display manager **120-1**.

In one embodiment, the media verifier **152**, running within the content display manager **120-1**, processes the preamble data **112** to determine an integrity of at least a portion of the preamble data **112**. If the preamble data **112** (e.g., an array of hash values) is found to be "trustworthy," then security information such as hash values in the preamble data **112** can be used to determine the integrity of any portion of content **110** that is received from the content repository **161**.

As an example, upon receipt of the desired portion of content **110**, the media verifier **152** extracts a hash value (from the security information in the preamble data **112**) that corresponds with the desired portion of content **110** to be processed or displayed. The media verifier **152** processes the extracted hash value to determine the integrity of the received portion of content **110**.

If the media verifier **152** determines that the received portion of content **110** is "trustworthy", then the content display manager **120-1** displays the "trustworthy" portion of content **110** on a display screen **130-1**. However, if the received portion of content **110** is "untrustworthy", then the content display manager **120-1** will not display the "untrustworthy" content portion. A "trustworthy" state of data signifies that data (e.g., metadata, array, hash value, preamble data) has not been corrupted by an unauthorized alteration. An "untrustworthy" state of data signifies that data has been likely been modified by an unauthorized source.

In one embodiment, the preamble data **112** can include an identifier value specifying advertisements that are related to the subject matter of the content portion being displayed on display screen **130-1**. For example, a server **172**, in communication with an advertisement repository **162**, can receive an identifier value retrieved from the preamble data **112** and forwarded by the content display manager **120-1** to the server **172**. Based on the identifier value, the server **172** locates advertisements in the advertisement repository **162** and transmits the advertisements to the content display manager **120-1**. The advertisements can thereby be displayed on the display screen **130-1** along with a requested portion of content **110**.

Note that the above discussion and example illustration are shown by way of example only and that the media verifier **152** can also be separately and concurrently running on multiple computer systems. For example, the media verifier **152** can be implemented within another content display manager **120-2** on a separate computer system **121-2** that has its own display screen **130-2**.

More specific details associated with media signer **150**, preamble data **112**, and media verifier **152** will now be discussed with respect to FIGS. **2-6**.

FIG. **2** is a block diagram of an example of a computer system configured with a media signer **150** according to embodiments herein. As shown, the media signer **150** applies a hash function **215** to each of multiple portions **210** (e.g., portion **210-1**, **210-2** . . . **210**-N) of content **110**.

A corresponding portion **210** of the content **110** can be a predefined set of data associated with the content **110**. For example, a portion **210** can include a set of bit information representing a page, paragraph, or section of a document, a segment of video, a segment of audio data, etc.

The media signer **150** generates a corresponding hash value **220-1** based on applying hash function **215** to portion **210-1**; the media signer **150** generates a corresponding hash value **220-2** based on applying hash function **215** to portion **210-2**; the media signer **150** generates a corresponding hash value **220-3** based on applying hash function **215** to portion **210-3**; and so on for each of the N values.

In one embodiment, the media signer **150** produces metadata **218** by organizing and storing the hash values **220-1**, **220-2** . . . **220**-N as an array of hash values **222**.

In addition to producing the array of hash values **220**, the media signer **150** applies a hash function **225** to the metadata **218** (including the array of hash values **222**) to create a hash value **230** of the metadata **218**. Thus, hash value of metadata **230** is a resulting "hash" of the array of hash values **222**.

Note that metadata **218** is not limited to including only hash values **220**. For example, metadata **218** can include other information relating to content **110** such as type information, version information, date of creation information, modification history information, user history information, etc.

After creating the hash value of the metadata **218**, the media signer **150** applies an encryption function **240** and encryption key **245** (e.g., a private key) to the hash value **230** of the metadata **218** in order to produce an encrypted hash value **245**. In one embodiment, the encrypted hash value of the metadata **250** is utilized to create a digital signature **260** for associating with the content **110**.

FIG. **3** is an example block diagram of preamble data **112** associated with content **110** according to embodiments herein. As depicted in FIG. **3**, the preamble data **112** includes a table of contents **315**, which describes characteristics of each portion **210-1**, **210-2** . . . **210**-N of the content **110**, and a document identifier **320** (i.e. a unique identifier value) that is associated with the content **110**. When the content **110** is retrieved for playback purposes, the table of contents **315** can be used (by a corresponding media player function) to determine parameters such as the size of each portion **210-1**, **210-2** . . . **210**-N of the content **110**, as well as each portion's **210-1**, **210-2** . . . **210**-N placement in the content **110**, etc.

The preamble data **112** also includes metadata **218** associated with the content **110**. The metadata **218** includes an array **222** of hash values **220-1**, **220-2** . . . **220**-N generated by media signer **150** in a manner as discussed above. Each of the hash values **220-1**, **220-2** . . . **220**-N corresponds with a particular **210-1**, **210-2** . . . **210**-N portion of the content **110**. Thus, the array **222** can store hash values for an arbitrary number of distinct portions of content (i.e. audio, videos, images, documents, etc.)

The preamble **112** also includes a digital signature **260**. In one embodiment, the digital signature **260** includes an encrypted hash value of metadata **250**, which is generated as discussed above.

Note that the discussion of the preamble data **112** including the table of contents **315**, the document identifier **320**, the metadata **218** and the digital signature **260** is shown by way of example and that the preamble **112** can be organized, parsed, maintained, etc. in a variety of ways.

As previously discussed, after generation of the preamble data **112**, the content **110** and corresponding preamble data **112** are made available for distribution to remote media players over a network. As discussed above and as discussed further below, the media verifier **152** at each remote media player utilizes the preamble data **112** to verify the integrity of received metadata and content **110** without requiring each remote media player to download the content it is entirety.

More specifically, FIG. **4** is a block diagram of an example of a computer system configured with a media verifier **152** for verifying the integrity of received metadata **218** according to embodiments herein. In FIG. **4**, the media verifier **152** receives and processes the preamble data **112** prior to playback of content **110**.

For example, assume that a user requests to view content **110** (or a portion thereof) on a corresponding media player application. In response to such a request, the media player application retrieves preamble data **112**. The media verifier **152** of the media player verifies an integrity of the preamble data **112** as follows:

The media verifier **152** applies a hash function **225** to metadata **218** included in the received preamble data **112**. The hash function **225** produces a hash value of received metadata **410**. Note that the hash function **225** used by the media verifier **152** is the same hash function **225** used by the media signer **150** as discussed above in FIG. **2** to produce the hash value of metadata **230**.

Referring again to FIG. **4**, the media verifier **152** also receives a digital signature **260** in the preamble data **112**. To decrypt an encrypted hash value **250** provided in the digital signature **260**, the media verifier **152** applies a decryption key **425** (e.g. a public key known and used by the media verifier **152**) of decryption function **420** to the encrypted hash value of metadata **250** to produce the hash value of metadata **230**. Via compare function **430**, the media verifier **152** compares the result **434** generated by the decryption function **420** (i.e., the hash value of metadata **230**) with the result **438** produced by hash function **225** (i.e., the hash value of received metadata **410**). The compare function **430** allows the media verifier **152** to determine a trust state (i.e. the integrity) of the received metadata **440**. For example, if the compare function **430** determines that the two result **434** and result **438** are equal, then the metadata **218** received in the preamble data **112** is deemed "trustworthy." If the compare function **430** determines that the result **434** and result **438** are not equal, the metadata **218** is "untrustworthy." In this latter case when the received metadata in preamble **112** is deemed untrustworthy, the media verifier **152** can prevent playback of all portions of the content **110**. In the former case, when the received metadata in preamble **112** is deemed trustworthy, the media verifier **152** can implement additional integrity checks whether or not to allow playback of different portions of the content **110** as discussed below in the following figures.

FIG. **5** is a block diagram of an example of a computer system configured with a media verifier **152** verifying the integrity of different received portions **210** of content **110** according to embodiments herein. As FIG. **5** illustrates, when the user sends a request **520** for a particular portion of content **210-2** to server **171**, the server **171** retrieves the requested portion **210-2** of content **110** from the content repository **161** and sends portion **210-2** over network **190** (e.g., a packet-switched network such as the Internet) to the content display manager **120**.

Via the content display manager **120**, the media verifier **152** receives the portion of content **210-2** that was requested by the user. The media verifier **152** applies a hash function **215** to the received portion of content **210-2** to produce a hash value of the received content portion **510**. Note again that the retrieved portion **210-2** of content **110** can be a page of a document, segment of video or audio, etc.

To perform the integrity check associated with the portion **210-2** of content **110**, the media verifier **152** also extracts the hash value **220-2** from the array of hash values **222**. Recall that hash value **220-2** is the hash value in array **222** that corresponds with the received portion of content **210-2**.

Compare function **525** of media verifier **152** compares the extracted hash value **220-2** with the hash value of received content portion **510** in order to determine a trust state of the received portion of content **530**. If both hash value **220-2** and hash value **510** are equal, then the received portion of content **210-2** is deemed to be "trustworthy". If both hash values **220-2** and hash value **510** are not equal, then the received portion of content **210-2** is deemed to be "untrustworthy." In the former case, when the portion **210-2** of content **110** is deemed trustworthy, the content display manager **120** enables a user to play back the retrieved portion **210-2** of content **110**. In the latter case, when the portion of content **110** is deemed untrustworthy, the content display manager **120** disables a user from playing back the retrieved portion **210-2** of content **110**.

Note that enabling and disabling of playing the content are shown by way of example and that the verification process as described herein can be used to enable and disable application of other functions to the retrieved content as well.

As discussed above, conventional play back systems can be configured to prevent play back of content by producing a digital signature for a grouping of content as a whole. In order to verify the content using the conventional digital signature, a user must retrieve the content in its entirety and thereafter apply a conventional verifier function to the content as whole to determine whether the content has been tampered with or corrupted.

Example embodiments as discussed herein significantly overcome the deficiencies of conventional applications, enabling a quicker display of content to a viewer. For example, a media verifier **152** performs a multi-level verification check prior to allowing play back of requested content **110**.

At a first level of the multi-level verification check, a media verifier **152** first verifies the integrity of a received array of hash values **222** associated with content **110**. If this initial verification step fails, the content display manager **120** prevents play back of the content **110** and portions thereof.

At a second level of the multi-level verification check, if the array of hash values **222** is deemed trustworthy in a manner as discussed above, then the content display manager **120** uses the array of hash values **222** to verify individual portions of carry out a second level verification step. For example, the content display manager **120** verifies an integrity of each portion of content prior to play back using the array of hash values **222**. Thus, there is no need to download and verify all portions of content **110** prior to playback as required by conventional methods.

Example embodiments are further advantageous over conventional techniques. For example, conventional techniques such as those discussed above in the background do not allow for determining which pages of a document are corrupted and which are still valid because the conventional verification test is based on an entirety of content rather than portions of content. Failure of the conventional verification test results in the inability to view any portions of the content. The user in such circumstances, therefore, may be prevented from viewing a desired page even though it may be that another page in a retrieved document that happens to be corrupted. In contradistinction and according to embodiments herein, if a retrieved array of hash values passes the verification test, then the array of hash values can be used to verify each requested portion of the content on a case-by-case basis. Certain portions of the content may be corrupt while other portions of retrieved content may not be corrupt. Use of incremental security (e.g., the array of hash values **222**) enable a user to access and view non-corrupted portions of a document (i.e., content **110**) even though other portions of the same document (i.e., content **110**) may be corrupted and, therefore, not usable.

FIG. **6** is a block diagram of an example of a computer system configured with a media verifier **152** enabling display of a "trustworthy" portion of content **210-2** with related advertisement information **620** according to embodiments herein.

When the trust state (i.e. the integrity) of received metadata **440** and the trust state (i.e. the integrity) of received content portion **530** are both deemed to be "trustworthy" by the media verifier **152**, the content display manager **120** utilizes display logic **610** to display the received portion of content **210-2** on a display screen **130**. The media verifier **152** also allows for the document identifier **320** (i.e. the unique identifier value) from the preamble data **112** to be sent to a server **172** that communicates with an advertisement repository **162**.

The advertisement repository **162** identifies an advertisement **620** that relates to the subject matter of the "trustworthy" content portion **210-2** being displayed on display screen **130**. The server **172** transmits the advertisement **620** to the content display manager **120**. The content display manager **120** initiates display of the advertisement **620** along with the "trustworthy" received portion of content **210-2** displayed on the display screen **130**. Accordingly, the user can view a retrieved portion of content **110** as well as a corresponding advertisement pertaining to the portion of content being viewed.

FIG. **7** is an example block diagram illustrating an architecture of a computer system that executes, runs, interprets, operates or otherwise performs a media signer application **150-1** and/or media signer process **150-2** (e.g. an executing version of a media signer **150** as controlled or configured by user **108**) according to embodiments herein. The media signer **150** can be configured to perform any of the operations associated with media signer **150**.

Note that the computer system **110** may be any type of computerized device such as a personal computer, a client computer system, workstation, portable computing device, console, laptop, network terminal, etc. This list is not exhaustive and is provided as an example of different possible embodiments.

In addition to a single computer embodiment, computer system **110** can include any number of computer systems (e.g., one or more computer systems) in a network environment to carry the embodiments as described herein.

As shown in the present example, the computer system **110** includes an interconnection mechanism **111** such as a data bus, motherboard or other circuitry that couples a memory system **117**, a processor **113**, an input/output interface **114**, and a display **130**. As discussed, the display screen **130** can be used to present display information such as a requested portion of content and an advertisement. An input device **116** (e.g., one or more user/developer controlled devices such as a keyboard, mouse, touch pad, etc.) couples to the computer system **110** and processor **113** through an input/output (I/O) interface **114**. The computer system **110** can be a client system and/or a server system.

As mentioned above, depending on the embodiment, the media signer application **150-1** and/or the media signer process **150-2** can be distributed and executed in multiple nodes in a computer network environment or performed locally on a single computer.

The memory system **117** can be any type of computer readable medium (e.g., tangible computer readable medium) and, in this example, is encoded with a media signer application **150-1** that supports corresponding operations as discussed herein.

During operation of the computer system **110**, the processor **113** accesses the memory system **117** via the interconnect **111** in order to launch, run, execute, interpret or otherwise perform the logic instructions of the media signer application **150-1**. Execution of the media signer application **150-1** in this manner produces the media signer process **150-2**. In other words, the media signer process **150-2** represents one or more portions or runtime instances of the media signer application **150-1** (or the entire application **150-1**) performing or executing within or upon the processor **113** in the computerized device **110** at runtime.

Those skilled in the art will understand that the computer system **110** may include other processes and/or software and hardware components, such as an operating system.

Display screen **130** need not be coupled directly to computer system **110**. For example, the media signer application **150-1** can be executed on a remotely accessible computerized device via the communication interface **115**. In this instance, the graphical user interface may be displayed locally to a user **108** of the remote computer, and execution of the processing herein may be client-server based.

FIGS. **8** through **14** include various flowcharts illustrating operations supported by the media signer **150** and the media verifier **152** according to embodiments herein. The rectangular elements shown in flowcharts **800**, **900**, **1000**, **1100**, **1200**, **1300** and **1400** denote "processing blocks" and represent computer software instructions or groups of instructions upon a computer readable medium. Additionally, the processing blocks represent steps performed by hardware such as a computer, digital signal processor circuit, application specific integrated circuit (ASIC), etc.

Flowcharts **800**, **900**, **1000**, **1100**, **1200**, **1300** and **1400** do not necessarily depict the syntax of any particular programming language. Rather, flowcharts **800**, **900**, **1000**, **1100**, **1200**, **1300** and **1400** illustrate the functional information one of ordinary skill in the art requires to fabricate circuits or to generate computer software to perform the processing required in accordance with the present invention.

It will be appreciated by those of ordinary skill in the art that unless otherwise indicated herein, the particular sequence of steps described is illustrative only and may be varied without departing from the spirit of the invention. Thus, unless otherwise stated, the steps described below are unordered, meaning that, when possible, the steps may be performed in any convenient or desirable order.

Referring now to FIG. **8**, FIG. **8** is a flowchart **800** of an example of processing steps performed by the media signer **150** to create a digital signature **260** according to embodiments herein.

At step **810**, the media signer **150** obtains an array of hash values **222** including a corresponding hash value **220-1**, **220-2** . . . **220**-N for each of multiple different portions **210-1**, **210-2** . . . **210**-N of content **110**.

In one embodiment, the media signer **150** generates the array **222** of hash values by retrieving and parsing the content **110** into data (e.g., a portion) that is associated with multiple displayable pages (e.g., portions). For example, the media signer **150** produces a first hash value by hashing data associated with a first displayable page. A second hash value can be produced by hashing data associated with a second displayable page. The media signer **150** then produces the array **222** to include the first hash value and the second hash value.

It is understood that the content **110** can include more than two displayable pages and that the media signer's **150** hash function **215** can produce a hash value corresponding to each displayable page of the content **110** or segments of the content other than pages.

At step **820**, the media signer **150** applies a hash function **225** to the array **222** of hash values to produce a hash value result **230**.

At step **830**, the media signer **150** utilizes the hash value result **230** to create a digital signature **260** associated with the content **110**.

It is understood that, for purposes of flowcharts **800**, **900**, **1000**, **1100**, **1200**, **1300** and **1400**, the array **222** of hash values can itself be metadata **218** (or part of metadata **218**) that is included in the preamble data **112**.

As illustrated, FIG. **9** is a flowchart **900** of an example of processing steps performed by the media signer **150** to produce the digital signature **260** based on an encrypted hash value result **250** according to embodiments herein.

At step **910**, by applying a hash function **215** (e.g. SHA-1 hash function), the media signer **150** generates a first hash value **220-1** based on a first portion **210-1** of the content **110**.

At step **920**, the media signer **150** similarly generates a second hash value **220-2** based on a second portion **210-2** of the content **110**.

At step **930**, the media signer **150** produces an array **222** of hash values to include the first hash value **220-1** and the second hash value **220-2** in the array **222**. The array **222** can be included in preamble data **112** as metadata **118**.

At step **940**, after the media signer **150** applies a hash function **225** to the array **222** in order to produce a hash value result **230**. The media signer **150** encrypts the hash value result **230**, thereby producing a digital signature **260** associated with the content **110**.

At step **950**, to encrypt the hash value result **230**, the media signer **150** obtains a private encryption key **245**.

At step **960**, the media signer **150** applies the private encryption key **245** to the hash value result **230** during an encryption function **240**.

At step **970**, the media signer **150** produces the digital signature **260**, which is based at least in part on the encrypted hash value result **250**. As previously discussed, the digital signature **260** can also be included in the preamble data **112**.

As depicted, FIG. **10** is a flowchart **1000** of an example of processing steps performed by the media signer **150** to generate a set of preamble data **112** according to embodiments herein.

At step **1010**, the media signer **150** generates a set of preamble data **112** to include the digital signature **260**.

At step **1020**, the media signer **150** generates the set of preamble data **112** to include a unique identifier value **320**. The unique identifier value **320** is utilized in the retrieval of advertisement information **620** that can be displayed along with "trustworthy" content **110** on a display screen **130**.

At step **1030**, the media signer **150** associates the set of preamble data **112** with the content **110**.

Turning now to FIG. **11**, FIG. **11** is a flowchart **1100** of an example of processing steps performed by the media verifier **152** to verify the integrity of a received array **222** of hash values according to embodiments herein.

At step **1110**, the media verifier **152** receives an array **222** of hash values. The array **222** of hash values includes a corresponding hash value **220-1**, **220-2** . . . **220**-N for each of multiple different portions **210-1**, **210-2** . . . **210**-N of content **110**. The array **222** can be metadata **218** in a set of preamble data **112** associated with the content **110**.

At step **1120**, the media verifier **152** applies a hash function **225** to the array **222** of hash values to produce a hash value result **410** for the array **222**.

At step **1130**, the media verifier **152** verifies the integrity of the received array **222** of hash values. Determining the received array's **222** integrity is based on the hash value result **410** produced for the received array **222**.

FIG. **12** is a flowchart **1200** of an example of processing steps performed by the media verifier **152** to determine whether the array **222** of hash values is trustworthy according to embodiments herein.

At step **1210**, the media verifier **152** receives an encrypted hash value result **250** in the preamble data **112**.

At step **1220**, the media verifier **152** decrypts the encrypted hash value result **250** to produce a decrypted hash value result **230**.

At step **1230**, the media verifier **152** compares the produced hash value result **410** for the array **222** with the decrypted hash value result **230** to determine an integrity of the received array **222** of hash values.

At step **1240**, upon determining that both hash value results **410**, **230** are not equal, the media verifier **152** provides an indication that the array **222** is "untrustworthy" in order to prevent access to the multiple different portions **210-1**, **210-2** . . . **210**-N of content **110**.

Upon determining that the produced hash value result **410** and the decrypted hash value result **230** are equal, at step **1250**, the media verifier **152** provides an indication that the array **222** of hash values is valid for use in determining an integrity of any of the multiple different portions **210-1**, **210-2** . . . **210**-N of content **110**.

FIG. **13** is a flowchart **1300** of an example of processing steps performed by the media verifier **152** to enable display of a received portion **210-2** of content **110** that is determined to be "trustworthy" according to embodiments herein.

At step **1310**, the media verifier **152** receives portions **210-1**, **210-2** . . . **210**-N of content **110** from a server **171** that communicates with a content repository **161**.

At step **1320**, the media verifier **152** applies a hash function **215** to a received portion **210-2** of content **110** to produce a hash value result **510** for that received portion **210-2** of content **110**.

At step **1330**, the media verifier **152** extracts a hash value **220-2** from the array **222** that corresponds with the received portion **210-2** of content **110**.

At step **1340**, in order to determine the integrity of the received portion **210-2** of content **110**, the media verifier **152** compares the produced hash value result **510** for the received portion **210-2** of content **110** with the hash value **220-2** extracted from the array **222**.

If the hash value result **510** for the received portion **210-2** of content **110** is equal to the hash value **220-2** extracted from the array **222**, at step **1350**, the media verifier **152** enables display of the received portion **210-2** of content **110**.

At step **1360**, the media verifier **152** disables display of the received portion **210-2** of content **110** if its hash value result **510** is not equal to the hash value **220-2** extracted from the array **222**.

As presented, FIG. **14** is a flowchart **1400** of an example of processing steps performed by the media verifier **152** to display an advertisement **620** with a "trustworthy" retrieved portion **210-2** of content **110** according to embodiments herein.

As previously discussed, an array **222** arrives at the media verifier **152** as metadata **218** within the preamble data **112**. The array **222** includes a hash value **220-2** that corresponds with the retrieved portion **210-2** of content.

At step **1410**, via use of the hash value **220-2** that corresponds with the retrieved portion **210-2** of content, the media verifier **152** detects that the retrieved portion **210-2** of content **110** has not been modified by an unauthorized source and is therefore "trustworthy."

At step **1420**, because the retrieved portion **210-2** of content **110** is "trustworthy," the media verifier **152** displays the retrieved portion **210-2** of content **110** on a display screen **130**.

At step **1430**, as the media verifier **152** decides to display the retrieved portion **210-2** of content **110**, the media verifier **152** extracts the unique identifier **320** from the set of preamble data **112**.

At step **1440**, the media verifier **152** transmits the unique identifier **320** to a server **172**, which stores advertisements **620** associated with the unique identifier **320**.

At step **1450**, the media verifier **152** receives an advertisement(s) **620** from the server **172** based on the unique identifier **320**.

At step **1460**, the media verifier **152** displays the advertisement(s) **620** with the retrieved portion **210-2** of content **110**.

Note again that techniques herein are well suited for a environment **100** with a media signer **150** and a media verifier **152**. The environment **100** detects whether a portion **210-1**, **210-2** . . . **210**-N of content **110** has been altered by an unauthorized source without requiring access to the content **110** in its entirety. Further, the environment **100** allows access to non-corrupted portions **210-2** of content even though other portions may be corrupted.

Note again that the embodiments described herein are not limited to a particular hardware or software configuration, and may find applicability in many different computing or processing environments. For example, embodiments herein can be implemented in hardware or software, or a combination of hardware and software.

Note further that embodiments herein can be implemented in one or more computer programs, where a computer program may be understood to include one or more processor executable instructions. As discussed above, such computer program(s) may be executed on one or more programmable processors, and may be stored on one or more storage medium readable by the processor (including volatile and non-volatile memory and/or storage elements), one or more input devices, and/or one or more output devices. The processor thus may access one or more input devices to obtain input data, and may access one or more output devices to communicate output data. The input and/or output devices may include one or more of the following: Random Access Memory (RAM), Redundant Array of Independent Disks (RAID), floppy drive, CD, DVD, magnetic disk, internal hard drive, external hard drive, memory stick, or other storage device capable of being accessed by a processor as provided herein, where such aforementioned examples are not exhaustive, and are for illustration and not limitation.

The computer program(s) may be implemented using one or more high level procedural or object-oriented programming languages to communicate with a computer system; however, the program(s) may be implemented in assembly or machine language, if desired. The language may be compiled or interpreted.

The device(s) or computer systems may include, for example, a personal computer(s), workstation(s) (e.g., Sun, HP, etc.), personal digital assistant(s) (PDA(s)), handheld device(s) such as cellular telephone(s), laptop(s), handheld computer(s), or another device(s) capable of being integrated with a processor(s) that may operate as provided herein. Accordingly, the devices provided herein are not exhaustive and are provided for illustration and not limitation.

Throughout the entirety of the present disclosure, use of the articles “a” or “an” to modify a noun may be understood to be used for convenience and to include one, or more than one of the modified noun, unless otherwise specifically stated.

Elements, components, modules, and/or parts thereof that are described and/or otherwise portrayed through the figures to communicate with, be associated with, and/or be based on, something else, may be understood to so communicate, be associated with, and or be based on in a direct and/or indirect manner, unless otherwise stipulated herein.

Although the methods and systems have been described relative to a specific embodiment thereof, they are not so limited. Obviously many modifications and variations may become apparent in light of the above teachings. Many additional changes in the details, materials, and arrangement of parts, herein described and illustrated, may be made by those skilled in the art.

What is claimed is:

1. A method comprising:

receiving, by a computing device, an array of hash values for respective portions of content, each of the portions being individual pages of a document or individual segments of audio or visual data;

applying, by the computing device, a hash function to the array of hash values to produce a hash value result for the array;

verifying, by the computing device, an integrity of the received array of hash values based on the hash value result produced for the received array of hash values; and

based on verifying the integrity of the received array of hash values:

retrieving a first portion of the content and a second portion of the content;

displaying the first portion of the content based on determining that a first hash value result generated by applying a hash function to the first portion of the content is equal to a first hash value from the array that corresponds to the first portion of the content; and

preventing display of the second portion of the content based on determining that a second hash value result generated by applying a hash function to the second portion of the content is different from a second hash value from the array that corresponds to the second portion of the content.

2. The method as in claim **1**, wherein verifying the integrity of the received array of hash values includes:

receiving an encrypted hash value result;

decrypting the encrypted hash value result to produce a decrypted hash value result; and

comparing the produced hash value result with the decrypted hash value result to determine an integrity of the received array of hash values.

3. The method as in claim **2**, wherein comparing the produced hash value result with the decrypted hash value result to determine the integrity of the array includes:

upon determining that the produced hash value result and the decrypted hash value result are equal, providing an indication that the array of hash values are valid for use in determining an integrity of the portions of content.

4. The method as in claim **3**, wherein determining an integrity of the portions of content includes:

receiving a portion of content;

applying a hash function to the portion of content to produce a hash value result for the portion of content;

extracting a hash value from the array that corresponds with the portion of content; and

comparing the produced hash value result for the portion of content with the hash value extracted from the array to determine an integrity of the received portion of content.

5. The method as in claim **1**, wherein receiving the array of hash values includes:

receiving the array of hash values in a set of preamble data associated with the content, the set of preamble data including a unique identifier for use in retrieval of advertising information associated with the content.

6. The method of claim **5** further comprising:

in response to detecting that a retrieved portion of the content has not been modified by an unauthorized source via use of a corresponding one of the array of hash values:

displaying the retrieved portion of the content;

extracting the unique identifier from the set of preamble data;

transmitting the unique identifier to a server, the server storing at least one advertisement associated with the unique identifier;

receiving an advertisement from the server based on the unique identifier; and

displaying the advertisement with the retrieved portion of the content.

7. The method as in claim **1**, wherein

the first hash value is generated based on applying a hash function to the first portion of the content and

the second hash value is generated based on applying a hash function to the second portion of the content.

8. A non-transitory computer readable medium comprising executable instructions encoded thereon operable on a computerized device to perform processing comprising:

instructions for receiving an array of hash values respective portions of content comprising non-executable data that is displayable by a computing device;

instructions for applying a hash function to the array of hash values to produce a hash value result for the array;

instructions for verifying an integrity of the received array of hash values based on the hash value result produced for the received array of hash values; and

instructions for performing, based on verifying the integrity of the received array of hash values, operations comprising:

retrieving a first portion of the content and a second portion of the content;

displaying the first portion of the content based on determining that a first hash value result generated by applying a hash function to the first portion of the content is equal to a first hash value from the array that corresponds to the first portion of the content; and

preventing display of the second portion of the content based on determining that a second hash value result generated by applying a hash function to the second portion of the content is different from a second hash value from the array that corresponds to the second portion of the content.

9. The computer readable medium as in claim **8**, wherein the instructions for verifying the integrity of the received array of hash values include:

instructions for receiving an encrypted hash value result;

instructions for decrypting the encrypted hash value result to produce a decrypted hash value result; and

instructions for comparing the produced hash value result with the decrypted hash value result to determine an integrity of the received array of hash values.

10. The computer readable medium as in claim **9**, wherein the instructions for comparing the produced hash value result with the decrypted hash value result to determine the integrity of the array of hash values include:

instructions for, upon determining that the produced hash value result for the array and the decrypted hash value result are not equal, providing an indication that the array is untrustworthy to prevent access to the portions of content.

11. The computer readable medium as in claim **9**, wherein the instructions for comparing the produced hash value result with the decrypted hash value result to determine the integrity of the array include:

instructions for, upon determining that the produced hash value result and the decrypted hash value result are equal, providing an indication that the array of hash values are valid for use in determining an integrity of the portions of content.

12. The computer readable medium as in claim **11**, wherein the instructions for determining an integrity of the portions of content include:

instructions for receiving a portion of content; instructions for applying a hash function to the portion of content to produce a hash value result for the portion of content;

instructions for extracting a hash value from the array that corresponds with the portion of content; and

instructions for comparing the produced hash value result for the portion of content with the hash value extracted from the array to determine an integrity of the received portion of content.

13. The computer readable medium as in claim **8**, wherein the instructions for receiving the array of hash values include:

instructions for receiving the array of hash values in a set of preamble data associated with the content, the set of preamble data including a unique identifier for use in retrieval of advertising information associated with the content.

14. The computer readable medium of claim **13** further comprising;

instructions for, in response to detecting that a retrieved portion of the content has not been modified by an unauthorized source via use of a corresponding one of the array of hash values;

displaying the retrieved portion of the content;

extracting the unique identifier from the set of preamble data;

transmitting the unique identifier to a server, the server storing at least one advertisement associated with the unique identifier;

receiving an advertisement from the server based on the unique identifier; and

displaying the advertisement with the retrieved portion of the content.

15. The computer readable medium as in claim **8**, wherein the first hash value is generated based on applying a hash function to the first portion of the content and

the second hash value is generated based on applying a hash function to the second portion of the content.

16. A computer system comprising:

a processor;

a memory unit that stores instructions associated with an application executed by the processor; and

an interconnect coupling the processor and the memory unit and enabling the computer system to execute the application and perform operations of:

obtaining an array of hash values for respective portions of content, each of the portions being individual pages of a document or individual segments of audio or visual data;

applying a hash function to the array of hash values to produce a hash value result;

verifying an integrity of the received array of hash values based on the hash value result produced for the received array of hash values; and

based on verifying the integrity of the received array of hash values:

retrieving a first portion of the content and a second portion of the content;

displaying the first portion of the content based on determining that a first hash value result generated by applying a hash function to the first portion of the content is equal to a first hash value from the array that corresponds to the first portion of the content; and

preventing display of the second portion of the content based on determining that a second hash value result generated by applying a hash function to the second portion of the content is different from a second hash value from the array that corresponds to the second portion of the content.

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